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PHYSICS AND EDUCATION

AT the recent meeting of the American Association for the Advancement of Science a joint session of Sections B, Physics, and L, Education, was devoted to a discussion of the teaching of physics. This is the first time in the history of the association that such a discussion has formed part of the regular program. It indicates the change that is slowly but surely creeping over the university mind of the country in that the problems of teaching are coming to be regarded as research problems of at least no less importance and difficulty than those of pure science. Section L, to be sure, devotes all its sessions to the presentation and discussion of research work in education; but it is encouraging to have Section B also turn its attention in this direction.

Those who attended this joint session have been impressed with the wide difference in the points of view from which the two sections surveyed the field. It is a familiar fact that specialists in any field are very wary about committing themselves definitely in reply to questions about their specialty. Ask a geologist what a specimen of rock is, and he will reply that it looks like limestone, and probably is that, but he would not care to be quoted as having said that it was limestone until he had made suitable tests and verified the statement carefully. The same geologist does not hesitate to give final decisions on matters of politics or even of education, although he has never studied either scientifically. He would even be ready to legislate about the re-

quirements that high schools must meet, although he has never seen the inside of a high school since he himself graduated. Yet he would legislate on the basis of vague impressions retained from his own school days and other vague impressions he has received from others. A very similar condition prevails with the two sections. Section B criticizes any new suggestion in physical science very searchingly, submits it to rigorous, unbiased tests and insists on satisfactory verification. Section L does the same in the field of education, but takes its physics largely on faith and with little attempt at criticism or verification. Section B treats suggestions in education as Section L does those in physics; but with this difference —L does not presume to dogmatize about physical science.

This fundamental difference in the attitudes of the two sections leads to a radical difference in their respective attitudes toward physics teaching. This difference was pointed out most lucidly by Professor Dewey in his vice-presidential address on "Science as Method and as Information." This difference is not sharply defined in that all members of B do not regard the imparting of information as the sole end of science instruction any more than all the members of L regard the acquirement of the scientific method of thinking as the sole aim of teaching. There is, however, a marked difference in the ways in which the two sections place the emphasis. For B, information is paramount and method of thinking subordinate; for L, the reverse is true.

From this prime difference between the two sections follow a number of subsidiary differences. These may be paired off in couples in some such way as that given below. It is, of course, not possible that the characteristics of the members of a pair be intrinsically and mutually exclusive. Nor is it claimed that Section B stands wholly and solely for the first set, and Section L wholly and solely for the second. It is again a matter of emphasis. Section B as a whole strongly emphasizes the elements in the first set; while L, in like manner, strongly emphasizes those in the second.

B	L
1. Logical arrangement of concepts.	Intuitive development of concepts.
2. Analytical reasoning with abstract ideas.	Good judgment in concrete cases.
3. Forestalling possible future needs of physicists.	Meeting actual present needs of students.
4. Power to pass possible examinations.	Power to act intelligently in actual situations.
5. Learning laws intellectually.	Power to solve problems scientifically.
6. Verbal statements of principles.	Weighing of evidence.
7. Intellectual attainment.	Social efficiency.
8. Satisfaction of college requirements for few.	Service to community for all.
9. Mental discipline.	Enthusiasm and motive.
10. Logical rigor.	Useful approximation.

Up to the present time the first set of characteristics have been dominant in physics teaching. It is for this reason that this teaching has not been satisfactory. The present problem is, not to make the other set as overbearing as the first has been, but to get a just balance between them. It is not that logical arrangement should be banished and intuitive development substituted; but that intuitive development should precede and lead up eventually to logical order. It is not that social efficiency precludes intellectual attainment; but that social efficiency should precede

in importance. The other will surely follow. The reverse is, however, not true—a man may have high intellectual attainments and be socially highly inefficient.

Again, it has been forcibly proved of late that when a high school tries seriously to meet college requirements, it fails egregiously in service to its community. On the contrary, when it serves its community efficiently, it should meet college requirements far better than at present. In like manner, mental discipline may be possible without enthusiasm and motive, but at best it trains the intellect only while the will runs riot with morality. But when enthusiasm and right motive precede, not only is the mind disciplined, but the will also, leading to firm character as well as intellectual strength.

But perhaps the difference between the two points of view is most forcefully shown in the respective attitudes of the two sections with regard to the use of physics for entrance to college. Section B has, as a whole, always regarded high-school physics as being taught mainly for purposes of college entrance. In this subject, more than in any other, the high schools have been "required" to try to teach what the colleges specified was "the thing." These specifications have always been framed by college men with a view to forestalling the needs of physicists and to securing a treatment of topics that should be the most logical and rigorous known in the then state of the sciences. College men have criticized elementary texts as if they were scientific treatises instead of tools for education and have denounced educationally insignificant departures from current scientific creed as illogical or unscientific. High-school men have never been encouraged to try experiments in teaching, in an endeavor to find out by experiment—the only possible way—what is best for high school pupils. And why should they try experiments when those who were masters of *physics* had said that the *teaching* must conform to these definitions?

Section L, on the other hand, can not accept the postulate that the straight and narrow path laid out by the colleges is the best way to teach elementary physics without scrutinizing closely the results of the work; any more than Section B will swallow Blondlot N rays without inspecting them carefully. Nor do we have to look far for conclusive evidence. Most of us find it in the examination books turned in by our students at every examination. As physics teachers we are amused at the "new knowledge" and utter nonsense contained in these books. We are so used to it that we have ceased to regard it as indicative of a serious condition. We laugh it off with the remark: "Every exam brings out samples like that." "And after all," argue the physicists, "what harm is done? The great majority of the pupils will not have to know how to calculate the velocity of a body sliding down a plane, nor will they be seriously handicapped in life if they do not know what the index of refraction is. If they do not know a thing, they should be taught to say they do not know instead of making up such nonsensical answers." In like manner we comfort ourselves for failures to make clear other portions of the subject, all leading to the very obvious question: Why attempt at all to teach such things under the name of physics that when a boy is questioned about them the only sensible answer he can give is "I don't know?" Perhaps some other member of Section B will answer this.

Another important test of results is given annually by the College Entrance Examination Board. The result is that out of fourteen questions set, about

seventy per cent. of the candidates fail to answer four correctly. Perhaps some of the colleges that examine entering students in physics can furnish more encouraging figures on this matter. So Section L is prone to conclude that the method prescribed by the colleges is failing to meet the expectations of the colleges as manifested in their examinations. Either the method or the examinations or both must be a misfit.

Even Section B is now half persuaded that this is so. But the blame is laid on the poor teacher who has been working his best to do faithfully what he was told to do and not on the college-born and bred specifications of the course nor on the examinations. As a cure it is urged that we need better prepared teachers, better laboratory facilities, better apparatus, and an attendant who is mechanically inclined, so that the teacher may have more leisure. We are told that physics teachers should have taken an M.A. in *physics,* should know some calculus and some chemistry: but not a word is said about knowing boys, understanding schools and having some idea of what a problem in education looks like and of how to go about to solve it—in a word, about having better *teachers.*

Section L agrees to the desirability of all the good things suggested by its colleagues B. But it is very certain that the trouble does not lie so much with the teacher and his apparatus as it does with the sort of a thing he is told to do, and the way in which the specifications were made and are administered. This conclusion is based on the fact that the course has been designed after a study of logical order, scientific rigor and the possible needs of physicists, and not after a scientific study of high school pupils and their needs and mental possibilities. No such study of pupils has, so far as I know, been made in America, excepting by President G. Stanley Hall; and, although everybody knows what his conclusions are, they have not yet received the attention that is due them. In a few cases President Hall's suggestions have been put into practise with great success, but the colleges have refused to give entrance credit for this most creditable work, thereby discouraging all but the bravest teachers from trying it.

Under the conditions that exist in the country to-day, the suggestion that better apparatus and teachers who know more *physics* are needed does not begin to solve the problem. The statistics of the bureau of education show that there are in the country in towns having more than 8,000 inhabitants but 800 high schools. These schools average 17 teachers each, and have 365,000 pupils. In the smaller towns there are 8,160 high schools having an average of 2.7 teachers each and 405,000 pupils in all. Therefore 53 per cent. of the pupils attend small high schools which have less than 6 teachers each. In such schools the man who teaches physics must also teach two or three other subjects. Therefore he must be a *teacher* rather than a *physicist.* Not more than one in ten of those who teach physics can be expected to have an extended knowledge of the subject.

In 1908 there were 29,000 high school graduates who were prepared for college. The number of those who study physics each year in the high schools is about 130,000. Not all who were prepared for college had studied physics. It is safe to say that not more than one in every five of those who studied physics used it for college entrance. Therefore the problem is not how shall we produce conditions in which the present quasi-rigorological *physics* shall be taught everywhere by specialists, in preparation for a profession that almost none follow; but rather how, under

existing conditions, we shall get for all who study it the best possible *teaching* of physics in the brief time allotted to this subject. This is not an easy problem, since it involves the reorganization of a large body of subject matter on a new basis—instead of being a logical system, it must be a teachable system. The emphasis must be shifted, so that it falls less heavily on the traits assigned above to Section B and more heavily on those ascribed to Section L.

The solution of this problem will take a long time and require much experimenting and much scientific study. It involves a careful study of how we obtain clear notions of physical principles—what part do our motor reactions and what part does our reason play in this process? We certainly do not come to understand a subject like acceleration by learning definitions and formulæ and solving never so many unreal numerical problems. In Germany much attention has been given recently to the experimental solution of this problem by Frey, Seyfert, Verworn, Remus[1] and others, not to mention their celebrated Unterrichtskommission. But in America nothing has as yet been done in this direction. America showed Germany the necessity of having laboratories for high schools; must we learn from her how to use them for the best educational results? Are we not competent to study this problem on our own account, and to solve it for ourselves in a way that will suit our own peculiar conditions?

Therefore, the partnership that has been started between B and L is an auspicious event, because both are parts of a scientific organization where all problems are solved in a scientific way. Certain it is that as suggestions for change are tried out in practise, as hypotheses are tested and submitted to scientific scrutiny and criticism, and as educational theories are verified by experiment, the points of view of the two sections will gradually approach each other. Who knows but that they may some day coincide?

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[1] Frey, O., "Arbeits unterricht," Leipzig, Wunderlich, 1907. Seyfert, R., "Die Arbeitskunde," Leipzig, 1902. Verworn, M., "Beiträge zur Frage des naturwissenschäftlichen Unterrichts an den höheren Schulen," Leipzig, Teubner, 1906. Remus, K., "Der Dynamologische Lehrgang," Leipzig, Teubner, 1906.

PROFESSORIAL ETHICS

WHEN I was at a university as an undergraduate—I will not say how many years ago—I received one morning a visit from a friend who was an upper classman; for, as I remember it, I was a freshman at the time. My friend brought a petition and wished to interest me in the case of a tutor or assistant professor, a great favorite with the college boys, who was about to be summarily dismissed. There were, to be sure, vague charges against him of incompetence and insubordination; but of the basis of these charges his partizans knew little. They only felt that one of the bright spots in undergraduate life surrounded this same tutor; they liked him and they valued his teaching. I remember no more about this episode, nor do I even remember whether I signed the petition or not. The only thing I very clearly recall is the outcome: the tutor was dismissed.

Twice or thrice again during my undergraduate life did the same thing happen —a flurry among the students, a remonstrance much too late, against a deed of apparent injustice, a cry in the night, and then silence. Now had I known more about the world I should have understood that these nocturnal disturbances were signs of the times, that what we had heard in all these cases was the operation of the

guillotine which exists in every American institution of learning, and runs fast or slow according to the progress of the times. The thing that a little astonished the undergraduate at the time was that in almost every case of summary decapitation the victim was an educated gentleman. And this was not because no other kind of man could be found in the faculty. It seemed as if some whimsical fatality hung over the professorial career of any ingenuous gentleman who was by nature a scholar of the charming old-fashioned kind.

Youth grieves not long over mysterious injustice, and it never occurred to me till many years afterwards that there was any logical connection between one and another of all these judicial murders which used to claim a passing tear from the undergraduates when I was in college. It is only since giving some thought to recent educational conditions in America that I have understood what was then happening, and why it was that a scholar could hardly live in an American university.

In America, society has been reorganized since 1870; old universities have been totally changed and many new ones founded. The money to do this has come from the business world. The men chosen to do the work have been chosen by the business world. Of a truth, it must needs be that offenses come; but woe be unto him through whom the offense cometh. As the boss has been the tool of business men in politics, so the college president has been his agent in education. The colleges during this epoch have each had a "policy" and a directorate. They have been manned and commissioned for a certain kind of service as you might man a fishing-smack to catch herring. There has been so much necessary business—the business of expanding and planning, of adopting and remodeling—that there has been no time for education. Some big deal has always been pending in each college—some consolidation of departments, some annexation of a new world—something so momentous as to make private opinion a nuisance. In this regard the colleges resembled everything else in America. The colleges have simply not been different from the rest of American life. Let a man express an opinion at a party caucus, or at a railroad directors' meeting, or at a college faculty meeting, and he will find that he is speaking against a predetermined force. What shall we do with such a fellow? Well, if he is old and distinguished, you may suffer him to have his say and then over-ride him. But if he is young, energetic and likely to give more trouble, you must eject him with as little fuss as the circumstances will permit.

The educated man has been the grain of sand in the college machine. He has a horizon of what "ought to be," and he could not help putting in a word and an idea in the wrong place; and so he was thrown out of education in America exactly as he was thrown out of politics in America. I am here speaking about the great general trend of influences since 1870, influences which have been checked in recent years, checked in politics, checked in education, but which it is necessary to understand if we would understand present conditions in education. The men who, during this era, have been chosen to become college presidents have, as a rule, begun life with the ambition of scholars; but their talents for affairs have been developed at the expense of their taste for learning, and they have become hard men. As towards their faculties they have been autocrats, because the age has demanded autocracy here; as toward the millionaire they have been sycophants, because the age has demanded sycophancy here. Mean-

while these same college presidents represent learning to the imagination of the millionaire and to the imagination of the great public. The ignorant millionaire must trust somebody; and whom he trusts he rules. Now if we go one step further in the reasoning and discover that the millionaire himself has a somewhat exaggerated reverence for the opinions of the great public, we shall see that this whole matter is a coil of influence emanating from the great public and winding up—and generally winding up very tight—about the necks of our college faculties and of our professional scholars. The millionaire and the college president are simply middle men, who transmit the pressure from the average citizen to the learned classes. What the average citizen desires to have done in education gets itself accomplished, though the process should involve the extinction of the race of educated gentlemen. The problem before us in America is the unwinding of this "knot intrinsicate" into which our education has become tied, the unwinding of this boa-constrictor of ignorant public opinion which has been strangling and, to some extent, is still strangling our scholars.

I have no categorical solution of the problem, nor do I, to tell the truth, put an absolute faith in any analysis of social forces, even of my own. If I point out one of the strands in the knot as the best strand to begin work on, it is with the consciousness that there are no doubt other effectual ways of working, and other ways of feeling about the matter that are more profound.

The natural custodians of education in any age are the learned men of the land, including the professors and schoolmasters. Now these men have, at the present time, in America no conception of their responsibility. They are docile under the rule of the promoting college president, and they have a theory of their own function which debars them from militant activity. The average professor in an American college will look on at an act of injustice done to a brother professor by their college president with the same unconcern as the rabbit who is not attacked watches the ferret pursue his brother up and down through the warren to predestinate and horrible death. We know, of course, that it would cost the non-attacked rabbit his place to express sympathy for the martyr; and the non-attacked is poor, and has offspring, and hopes of advancement. The non-attacked rabbit would, of course, become a suspect, and a marked man the moment he lifted up his voice in defense of rabbit-rights. Such personal sacrifice seems to be the price paid in this world for doing good of any kind. I am not, however, here raising the question of general ethics; I refer to the philosophical belief, to the special theory of *professorial* ethics which forbids a professor to protect his colleague. I invite controversy on this subject; for I should like to know what the professors of the country have to say on it. It seems to me that there exists a special prohibitory code, which prevents the college professor from using his reason and his pen as actively as he ought in protecting himself, in pushing his interests and in enlightening the community about our educational abuses. The professor in America seems to think that self-respect requires silence and discretion on his part. He thinks that by nursing this gigantic reverence for the idea of professordom, such reverence will, somehow, be extended all over society, till the professor becomes a creature of power, of public notoriety, of independent reputation as he is in Germany. In the meantime, the professor is trampled upon, his interests are ignored, he is over-worked and

underpaid, he is of small social consequence, he is kept at menial employments and the leisure to do good work is denied him. A change is certainly needed in all of these aspects of the American professors' life. My own opinion is that this change can only come about through the enlightenment of the great public. The public must be appealed to by the professor himself in all ways and upon all occasions. The professor must teach the nation to respect learning; he must make the nation understand the function and the rights of the learned classes. He must do this through a willingness to speak and to fight for himself. In Germany there is a great public of highly educated, nay of deeply and variously learned people whose very existence secures pay, protection and reverence for the scholar. The same is true in France, England and Italy.

It is the public that protects the professor in Europe. The public alone can protect the professor in America. The proof of this is that any individual learned man in America who becomes known to the public through his books or his discoveries, or through his activity in any field of learning or research is comparatively safe from the guillotine. His position has at least some security, his word some authority. This man has educated the public that trusts him, and he can now protect his more defenseless brethren if he will. I have often wondered, when listening to the sickening tale of some brutality done by a practical college president to a young instructor, how it had been possible for the eminent men upon the faculty, to sit through the operation without a protest. A word from any one of them would have stopped the sacrifice and protected learning from the oppressor. But no, these eminent men harbored ethical conceptions which kept them from interfering with the practical running of the college. Merciful heavens! who is to run a college if not learned men? Our colleges have been handled by men whose ideals were as remote from scholarship as the ideals of the New York theatrical managers are remote from poetry. In the meanwhile, the scholars have been dumb and reticent.

At the back of all these phenomena we have, as I have said, the general atmospheric ignorance of the great public in America. We are so used to this public, so immersed in it, so much a part of it ourselves, that we are hardly able to gain any conception of what that atmospheric ignorance is like. I will give an illustration which would perhaps never have occurred to my mind except through the accident of actual experience. If you desire a clue to the American character in the matter of the higher education, you may find one in becoming a school trustee in any country district where the children taught are the children of farmers. The contract with any country school-teacher provides that he shall teach for so many weeks upon such and such conditions. Now let us suppose a teacher of genius to obtain the post. He not only teaches admirably, but he institutes school gardens for the children; he takes long walks with the boys and gives them the rudiments of geology. He is in himself an uplifting moral influence and introduces the children into a whole new world of idea and of feeling. The parents are pleased. I will not say that they are grateful; but they are not ungrateful. It is true that they secretly believe all this botany and moral influence to be rubbish; but they tolerate it. Now, let us suppose that before the year is out the teacher falls sick, and loses two weeks of school time through absence. You will find that the trustees insist upon his making up this lost time: the contract calls for it. This seems

like a mean and petty exaction for these parents to impose upon a saint who has blessed their children unto the third and fourth generation by his presence among them. But let us not judge hastily. This strange exaction does not result so much from the meanness of the parents as from their intellectual limitations. To these parents the hours passed in school are schooling; the rest does not count. The rest may be pleasant and valuable, but it is not education.

In the same way, the professional and business classes in America do not see any point in paying salaries to professors who are to make researches or write books, or think beautiful thoughts. The influence which an eminent man sheds about him by his very existence, the change in tone that comes over a rude person through his once seeing the face of a scholar, the illumination of a young character through contact with its own ideals—such things are beyond the ken of the average American citizen to-day. To him, they are fables, to him they are foolishness. The parent of our college lad is a farmer compared to the parent of the European lad.

The parent regards himself as an enlightened being—yet he has not, in these matters, an inkling of what enlightenment is. Now, the intelligence of that parent must be reached; and the learned classes must do the work of reaching it. The fathers of the christian church made war with book and speech on paganism. The leaders of the reformation went out among the people and made converts. The patriots of the American revolution—nay, the fathers of modern science, Tyndall, Huxley, Louis Agassiz, Helmholtz—wrote popular books and sought to interest and educate the public by direct contact. Then let the later-coming followers in learning imitate this popular activity of the old leaders; we need a host of battlers for the cause.

For whom do these universities exist, after all? Is it not for the people at large? Are not the people the ultimate beneficiaries? Then why should the people not be immediately instructed in such manner as will lead to their supporting true universities? It is hard to say why our professors are so timid. Perhaps too great a specialization in their own education has left them helpless as all-around fighters. But the deeper reason seems to be a moral one; they think such activity is beneath them. It is not beneath them. Whatever be a man's calling, it is not beneath him to make a fight for the truth. As for a professor's belonging to a mystic guild, no man's spiritual force is either increased or diminished by the name he calls his profession. Learning is their cause, and every honest means to promote learning should be within their duty. Nor does duty alone make this call to publicity. Ambition joins in it; the legitimate personal ambition of making one's mind and character felt in the world. This blow once struck means honor, and security of tenure in office, and public power.

In fine, the scholars should take the public into their confidence and dominate the business men on our college boards. This will be found more easy than at first appears, because the money element, the millionaire element, is very sensitive to public feeling, and once the millionaire succumbs, the college president will succumb also. The step beyond this would consist in the scholars taking charge of the college themselves, merely making use of certain business men on their boards for purposes of financial administration.

JOHN JAY CHAPMAN

BARRYTOWN, N. Y.

ADDRESS AT ANNUAL BANQUET OF THE AMERICAN CHEMICAL SOCIETY[1]

It is a pleasure and an inspiration to be present at a gathering of so many men devoted to the advancement of the great science of chemistry. The striking growth in the numbers of your society in recent years typifies the growing interest in the science and the growing appreciation of its importance in the industrial life of the nation. Many think that the twentieth century will be preeminently the century of the chemist; that as the nineteenth century was marked mainly by the triumphs of physics—the development of steam and gas engines, of electricity as a means of power and of communication—so this century will be signalized by applications of chemistry that will once more thrust us into an entirely new world. There seems indeed to be some good ground for such an expectation. Already great things have been accomplished—as we see by a glance at our cotton industries, dye works and countless other interests that chemistry has revolutionized. But there is no feeling of having worked out the lode; the possibilities of the future seem almost infinite and all our hopes are high. We must, however, never allow ourselves to lose sight of the fact that we shall certainly fail unless we keep industry in the closest possible touch with science. The awful example, the standing warning in this respect is of course the case of England. There, a few years ago, they celebrated the fiftieth anniversary of an English chemist's epoch-making discovery of mauve, and yet the jubilee in honor of this man of science was the occasion of the funeral oration of the color industry in his own country. This deplorable result was brought about entirely by two things that are closely related—first, the failure to keep industry in close touch with science, and second, the impatience of the manufacturer and his narrowness as a self-styled "practical" man. The practical Englishman is too apt to be impatient of the slow processes of research. He wants to be compensated in hard cash and at once. The German, on the other hand, has learned to be no less practical, but he has retained the traditions of a race of idealists plodding patiently and surely to success. Now I need hardly say to you that it is not wise for us to spend much time in bemoaning or still worse in jeering at England in this matter. Let us look to ourselves. We are not, I think, specially remarkable for *patience*, and I doubt very much whether we are doing all that can be done to keep industry and science in the closest possible touch.

But the field of *industrial* chemistry is not the only one in which the times are critical and exacting. This is equally true of the pure science itself. I hope my own predilection for physics does not mislead me into thinking that the most conspicuous development of chemistry during the past quarter of a century has been on the physical side; but in any case there can be no question that the artificial boundaries between physics and chemistry are being rapidly removed, and of course it is well to have it frequently brought home to us that all such boundaries are purely artificial. A disturbance in one field is sure sooner or later to extend to the other. In physics we have had a veritable earthquake which has shaken the whole structure to its foundations, and I understand that not a few of the chemists have been so much impressed, not so much by the actual shaking of the building as by the cries of the expectant victims, that they are beginning to run. I would exhort such people to be calm, and not be too ready to throw away conceptions (such, *e. g.*, as that of an atom), conceptions that have proved very valuable as aids to the advancement of the science in the past. It is true, of course, that the poor old atom has been a great deal battered in its history—even in the short time since the famous examinee described it as "a square block of wood first constructed by Dr. Dalton." It has been at one time a hard inelastic sphere, again a pulsating spherical shell, at another time simply a hole in the ether, or a vortex ring, sometimes it has appeared like a member of the British House of Lords—a mere center of in-

[1] By Richard C. Maclaurin, Sc.D., LL.D., president of the Massachusetts Institute of Technology.

ertia—at another it has looked more like a radical, as a storehouse of energy, endowed occasionally in the higher flights of the imagination with a reasonable soul, sometimes it has taken very high ground as a point singularity in a mathematical function, and now in its weariness it has at last compromised itself by claiming to be not an atom at all, but a solar system of electrons, each of these being that simple and transparent thing—a center of strain in the ether. However, in all these guises it has never ceased to be a useful conception to the working chemist and thereby has justified its existence. All these changes serve to emphasize two matters of some importance. The first is that it is well for us men of science to realize the limitations of our knowledge and to recognize that we don't know much about an atom, or of any of those concepts which we often so loosely describe as fundamental. Tyndall rightly objected to people who professed to be too much in the secrets of providence. He certainly, however, exposed himself to attack when he launched the famous phrase that caused so much fluttering in the dovecots—the statement that he could see within an atom "the promise and the potency of all that is." It is a legitimate flight of the scientific imagination to see anything at all in an atom; but it may be expedient for the special purposes of science not to see too much.

The other point suggested by recent experiences is that we should pay more serious attention than we usually do to the logic of science and have as clear ideas as possible as to what we are really aiming at, as to what we can reasonably expect to do and not to do. I doubt very much whether it is wise to wait in patient expectation for the years that bring, or are supposed to bring, the philosophic mind. A little artificial stimulus towards philosophy might accelerate the process. It seems to me extremely unfortunate that men of science are still so much scared by the bogey of metaphysics. What we have to be afraid of is not metaphysics but bad metaphysics, and it is difficult to accept the simple faith of many a man of science that his metaphysics is to be preferred to any other brand merely because it is either unconscious or naïve. A little quiet thought and study should at least have the good effect of enabling us to preserve our calm when things seem to be tumbling down. It should help us to realize that a science like chemistry is above all else a work of art, and that concepts like atoms, energy and the like are not much more than pigments with which we paint our pictures. The next generation may find new pigments or mix the old ones differently. Let us hope that they will find the same artistic satisfaction in filling in the picture and that the effect will be even more beautiful than is your science of to-day.

THE SALARIES OF PROFESSORS AT YALE UNIVERSITY[1]

WE are face to face with a necessity which we must meet in order to continue to do our work properly; and that necessity is a substantial increase of the salaries of many members of the teaching force. For those who are giving full time to the work of instruction our present normal salary scale is as follows: Instructors, first yeear, $1,000; second year, $1,200; third year, $1,400, fourth year and thereafter, $1,600; assistant professors, first term of service, $1,800; second term of service, $2,500; professors, $4,000.

It is at the very top, in the matter of salaries of professors themselves, that the inadequacy of our present rate of pay is most strongly felt. It is there that the legitimate demands of the individual and the legitimate needs of the university coincide in demanding large increases of salary.

To begin with, this is the one point in which we stand, we think, at a disadvantage as compared with our competitors. The salaries of Yale professors doing full work run all the way from $3,500 to $5,000; but the number who receive $5,000, or even $4,500, is comparatively small. Harvard, on the other hand, has a scale of professional salaries running from $4,500 to $5,500; and the number of professors who are there on the highest grade or have reasonable expectation of being so, is very

[1] From the annual report of President Hadley.

large. Harvard is probably the only university where the average salary of a full professor is higher than ours. But there are a number of institutions which offer individual members of their professional staff who can do exceptionally good service salaries ranging from $6,000 to $7,500.

But why, it may be asked, has this difference been allowed to exist so long? Why have the best Yale professors only received $4,000, or at most $5,000, while men of equal rank at other institutions have obtained substantially larger pecuniary returns? There are two main causes for this, both of which, curiously enough, have arisen within the professorial body itself. One is the fact, wholly creditable to our professors, that they have cared more for the extension of their teaching facilities than for the increase of their pay; the other is the spirit of professional equality which is zealous of all discriminations, no matter what their ground may be.

The permanent officers are quite ready to allow some distinguished man of mature years to be called from abroad with their approval at a salary higher than their own. They are rather unwilling to let some of their own associates, equally good, be given a similar salary by act of the corporation. They hold that in general all the professors in the same faculty should have the same salary, because they believe that this is the only way in which professorial independence can be secured.

It seems clear that the corporation has not only the right but the duty to raise the salary of a man who is now receiving $4,000 to $6,000 if that man clearly merits the increase, without being thereby compelled to raise the salary of another man in similar position who is rendering the institution little or no service. The corporation which calls a man to Yale as a professor agrees to pay him $4,000 as long as he is guilty of no grave dereliction which warrants that body in demanding his resignation. It does not agree that it will always pay him as much as any of his colleagues; nor does it agree that he and his colleagues in joint meeting shall have the right and duty to decide upon his salary increase. It is essentially a matter between the corporation and the individual.

If this principle is once accepted there will be no difficulty in putting Yale on a full equality with her strongest competitors in the matter of professors' salaries. If this is not accepted, the only alternatives are to raise all salaries alike or to have the members of the faculty discuss in one another's presence the relative shares which each should have. The first of these alternatives is unsatisfactory; the second positively bad. It appears far less dangerous, as well as far more practicable, to let the corporation arrange salaries and salary schedules with the advice of the deans or directors, with the full understanding that they may deal with individual cases on their merits.

The salaries which we pay assistant professors have been characterized as low. It may not improbably be desirable to raise the rate of pay for the first appointment as assistant professor from $1,800 to $2,000. The case of the assistant professors in their second term who are now receiving $2,500 presents more difficulty. As we look at each individual case the payment seems conspicuously inadequate. Many of these men have been teaching a dozen years; most of them are married; some have families of considerable size. They are competent scholars and devoted teachers. As individuals they deserve higher pay. As a policy, I am inclined to think that it would be a mistake to give them higher pay.

Why this apparent contradiction? Because it is bad both for the university and for the man himself to make a subordinate position too attractive for a man who is not likely to reach the top. If a man after eight years' work as an assistant professor has not proved his claim to promotion, the chances are that he never can prove it. What shall we do? Recognize his merit by a moderate increase of salary which will encourage him to stay, or indicate to him frankly that he had better seek his fortune elsewhere? The latter alternative is sometimes hard to put into effect, but I am convinced that it is true kindness.

A man can get a new position far more easily at thirty or thirty-five than he can at forty. The difficulties in making the change are less; the possibilities open to him after the change are on the whole greater. He can more easily adapt himself to new conditions; he has more years in which to build up an independent reputation. No such man should be compelled to leave Yale's service with inadequate notice. That would be unfair to him and suicidal to Yale. But it is, I believe, in the interests of all parties, and conspicuously in the interest of the assistant professor himself, that he should be encouraged to go elsewhere rather than kept at home by an advance in salary which, however attractive for the moment, is bound to be unsatisfactory in the long run.

In the case of assistant professors whom we have for one reason or another kept at Yale until they have become to all intents and purposes permanent officers, an increase of salary to $3,000 is probably wise and justifiable. But a salary scale which should increase the number of officers of this kind does not appear to be wise.

SCIENTIFIC NOTES AND NEWS

PROFESSOR THEODORE W. RICHARDS, of Harvard University, has accepted the invitation of the Chemical Society (London) to deliver the next Faraday Lecture, at a date to be announced later. This will be the tenth Faraday Lecture, the others having been given by the following chemists and physicists; Dumas, 1869; Cannizzaro, 1872; Hofmann, 1875; Wurtz, 1879; Helmholtz, 1881; Mendeléef, 1889; Rayleigh, 1895; Ostwald, 1904; Emil Fischer, 1907.

PRINCETON UNIVERSITY has conferred its doctorate of laws on Dr. William H. Welch, professor of pathology at the Johns Hopkins University.

YALE UNIVERSITY has conferred its doctorate of laws on Dr. C. D. Walcott, secretary of the Smithsonian Institution; its doctorate of letters on Mr. John Burroughs, and its doctorate of science on Dr. T. B. Osborne, chemist at the Connecticut Agricultural Experiment Station, and on Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research.

HOBART COLLEGE has conferred the degree of doctor of science on Dr. Warren P. Lombard, professor of physiology at the University of Michigan and Dr. Henry Rutgers Marshall, of New York.

RUTGERS COLLEGE has conferred the degree of doctor of science on Dr. Egbert LeFevre, of the class of 1880, dean of the medical faculty of the University of New York, and Professor Francis Cuyler Van Dyck, of the class of 1865, professor of physics and dean at Rutgers.

ST. JOHN'S COLLEGE, at its commencement on June 15, conferred the degrees of LL.D. on Dr. Marcus Benjamin, of the U. S. National Museum.

AT the meeting of the trustees of Cornell University, June 23, Professor Burt G. Wilder, the last active member of the original faculty, having resigned after a service of forty-two years, was made emeritus professor of neurology and vertebrate zoology.

PROFESSOR WESLEY MILLS is retiring from the chair of physiology at McGill University after twenty-five years' service.

DR. ALFRED G. MAYER, director of the department of marine biology of the Carnegie Institution of Washington, has been appointed lecturer in biology at Princeton University for next year.

DR. W. H. BOYNTON, instructor in pathology in the New York State Veterinary College, has left for the Philippine Islands, where he has accepted the position of pathologist of the veterinary service.

MR. P. H. COWELL, first assistant in the Greenwich Observatory, has been appointed director of the Nautical Almanac.

DR. WILLIAM EDWARD STORY, professor of mathematics at Clark University since 1889, was presented with a loving cup and a volume of letters from many of his mathematical friends at a banquet given in his honor at the Worcester Club on the evening of Monday, June 13. The book of letters contained one

from Professor Darboux, of Paris, as well as contributions from nearly all the heads of the departments of mathematics and many other professors in the American universities. Dean Frederick C. Ferry, of Williams College, acted as toastmaster, and speeches were made by President G. Stanley Hall, of Clark University; President Edmund C. Sanford, of Clark College, Professor James Pierpont, of Yale University, and Professor Arthur G. Webster, Professor Henry Taber, Dr. Louis N. Wilson, Professor Clifton F. Hodge and Professor Frank B. Williams, of Clark University. The dinner marked the completion by Dr. Story of thirty-five years of the teaching of mathematics at Harvard University, the Johns Hopkins University and Clark University.

A SCIENTIFIC expedition to the west-central part of Labrador for the present summer has been organized by Professor Raymond McFarland of Middlebury College. The expedition will go to Lake Mistassini by way of the Chamouchouan River and File Axe Lake, and thence to the eastward where field work and study of the unexplored region about Little Lake Mistassini and Lake Temiscamie will be made. He will be accompanied by Professors Thomas C. Brown and Phelps N. Sweet, both of Middlebury College.

PROFESSOR C. S. SCHUCHERT, of Yale University, and Mr. Twenhope, of the graduate school, have engaged a schooner for exploration of the shores of northwestern Newfoundland and Labrador.

PROFESSOR H. F. CLELAND, geology, has received leave of absence from Williams College for the first semester of next year, and Professor W. I. Milham, astronomy, leave of absence for the second semester.

THE death is announced of Charles Staniland Wake, connected with the Field Museum of Natural History, and known for his work in ethnology, born in England in 1835.

JOHN WILLIAM CRITCHLEY, chief taxidermist of the Museum of the Brooklyn Institute of Arts and Sciences, died at his home in Brooklyn, N. Y., May 24, of cirrhosis of the liver. That date marks the end of a long and useful career in museum taxidermy, which began at Ward's Natural Science Establishment in 1877, and ended with eight years of work in the Brooklyn Museum. In that institution his mounted mammals, great and small, constitute a fitting and permanent memorial to his skill, thoroughness and industry as a preparator. Perhaps Mr. Critchley's chief claim to distinction lies in the fact that in the saving and successful mounting of valuable zoological rarities that were about to become a total loss to science, his skill was really marvelous. His handiwork is widely scattered through the museums of America, but by far the largest and best collection of it is to be seen in the Brooklyn Museum. Especially noteworthy are his polar bear and fur-seals.

THE anniversary meeting of the New York Academy of Medicine to be held on Thursday, November 17, 1910, will be devoted to the subject of animal experimentation in medicine, with the following program:

"The Influence of Anti-vivisection on the Character of its Advocates," Professor Wm. W. Keen, Philadelphia.

"Objections to Proposals of Further Legislation to Regulate Animal Experimentation," Dr. Wm. H. Welch, professor of pathology in the Johns Hopkins University.

"The Character of Anti-vivisection Literature," Dr. W. B. Cannon, professor of physiology at the Harvard Medical School.

THE sixth annual meeting of the Southern Society for Philosophy and Psychology will be held in conjunction with the meetings of the Southern Educational Association at Chattanooga, Tenn., December 27–29.

THE University of Southern California at Los Angeles, has recently established a marine biological station at Venice, Cal. The station is on the nearest beach to the university, some thirteen miles distant. It comprises an aquarium consisting of forty tanks with running sea water and a series of laboratories for class work and research. The tanks are built of Catalina marble with glass on four sides and lighted in such a manner as to

give the greatest efficiency for study. The laboratories, which face the north, are provided with sea water and fresh water. The station is designed to afford: (1) facilities for demonstration to classes studying marine life; (2) opportunity for the students of the university who have major subjects in zoology and botany to carry on advanced work in marine biology, and (3) a limited number of research laboratories, some of which are available, without cost, to investigators who are prepared to carry on research work in some of the phases of marine biology. Applications for use of the research laboratories should be made to the director of the station, Albert B. Ulrey, University of Southern California, Los Angeles, Cal.

THE 1910 biennial convocation of Alpha Chi Sigma, the professional chemical fraternity, is to be held in Madison, Wisconsin, on June 23, 24 and 25. This order was organized at the University of Wisconsin in 1902, and now has chapters in nearly all the more important universities and technical schools of the middle west. Its membership is made up of professional chemists, teachers of chemistry, and the most proficient of the advanced students who intend to make some branch of chemistry their life work.

THE new U. S. Forest Products Laboratory established at the University of Wisconsin by the national Forest Service of the Department of Agriculture was dedicated on June 4 with exercises, in which Chief Forester Henry S. Graves, President C. R. Van Hise, of the University of Wisconsin; Governor J. O. Davidson, of Wisconsin, and ex-Governor W. D. Hoard took part. Mr. Graves, in his address, outlined the work to be undertaken by the laboratory, including reduction of the present waste of three fourths of every tree felled; utilization of all forest products to the best advantage; extension of aid directly to all wood-using industries, including paper manufacturers, lumber companies, furniture and other wood-working organizations; and conservation of the forests in the broadest sense. President Van Hise emphasized the mutual advantage of the location of the laboratory at the University of Wisconsin, in a state the greater part of which is better adapted to forests than to other growths. The experts of the laboratory staff, some twenty in number, will deliver lecture courses to the students of the university, who will also be given opportunity for advanced research work in the problems undertaken by the government in the making of cheaper print paper from other woods than spruce and hemlock, distillation of wood alcohol and turpentine from stumps, sawdust and other material now wasted, the protection of timbers against insect and fungus enemies, and the testing of the strength of timbers for different uses. The building, a three-story brick structure trimmed with white sandstone, is fire proof, and cost the University of Wisconsin $75,000. The government has equipped it at a cost of some $75,000, a part of the apparatus having been brought from the discontinued government laboratories at Purdue, Yale and Washington, D. C., when the Forest Service decided to concentrate its work at Wisconsin. The staff of forestry experts in the new laboratory includes: McGarvey Klein, Purdue, director; H. S. Bristol and H. S. Weiss, both of Yale University, assistant directors; H. D. Tiemann, Stevens Institute of Technology, in charge of technology; Ralph Thelen, University of California, mechanical engineer; W. H. Kempfer, University of Michigan, in charge of maintenance; Edwin Sutermeister, Massachusetts Institute of Technology, in charge of wood pulp laboratory; E. Bateman, Yale, in charge of chemistry; L. F. Hawley, Cornell, in charge of wood distillation; Frederick Dunlap, Cornell, in charge of kiln drying operations; F. W. Bond, Massachusetts Institute of Technology, in charge of wood preservation; C. T. Barnum, Cornell, and C. P. Winslow, Yale, engineers in wood preservation; J. A. Newlin, Purdue, in charge of timber tests; H. E. Surface, Ohio State University, engineer in wood chemistry; H. E. McKenzie, University of Maine, engineer in timber tests; C. J. Humphrey, University of Nebraska, and Cornell, pathologist, and A. W. Schorger, Ohio State University, chemist.

The fifth International Ornithological Congress was opened in Berlin on May 30 with 250 members in attendance and Professor Anton Reichenow presiding. Director Otto Herman, Count Arrigoni degli Oddi, Mr. Buturlin, Mr. H. E. Dresser, Professor Lönnberg, Dr. Světlik, Baron Snouckaert van Schauburg and M. Ternier were chosen vice-presidents of the Congress, and the following appointments of sectional presidents were made: I., anatomy, paleontology, classification and geographical distribution, Mr. Walter Rothschild, Dr. Hartert and Dr. Menegaux; II., Migration, Director Otto Herman, Mr. Reiser and Dr. Parrot; III., biology, oology, acclimatization and aviculture, Herr Amtsrat Nehrkorn, Dr. Bültikofer and the Rev. F. C. R. Jourdain; IV., bird protection and the care of natural monuments, Freiherr von Berlepsch, Herr von Kazy and Dr. Hennicky; V., poultry and poultry rearing, Herr Burchard, Herr Bähr and Kammerherr von Gontscharoff.

In connection with the annual grant voted by the British parliament in aid of scientific investigations concerning the causes and processes of disease, the following special researches have been authorized: (1) A continuation of an investigation into protracted and recurrent infection in enteric fever, by Dr. Theodore Thomson, Medical Inspector of the Board, in conjunction with Dr. Ledingham, of the Lister Institute. (2) A continuation of an investigation into protracted and recurrent infection in diphtheria, by Dr. Theodore Thomson and Dr. C. J. Thomas. (3) A continuation of an investigation into flies as carriers of infection, by Dr. Monckton Copeman, Medical Inspector of the Board, in conjunction with Dr. Graham Smith and Mr. Merriman, of the University of Cambridge, Dr. Nicholl, of the Lister Institute, and Dr. Bernstein, of the Bacteriological Laboratory, Westminster Hospital. (4) A continuation of an investigation on the injurious gases evolved during artificial illumination, by Dr. J. Wade, D.Sc., of Guy's Hospital. (5) A preliminary inquiry into the relationship of certain special types of bacteria to the diarrhœa of infants, by Dr. C. J. Lewis, of Birmingham, Dr. Sheila M. Ross, of Manchester, Dr. Thomas Orr, of Shrewsbury, and Dr. R. A. O'Brien, of the Lister Institute.

A controversy has arisen between some of the railroads of the country and the larger live stock shippers in regard to the space in the cars which must be afforded animals in transit from one state to another in order to make unloading unnecessary and still comply with the twenty eight-hour law. This law provides that when the animals are carried in cars "in which they can and do have proper food, water, space and opportunity to rest" they shall not be required to be unloaded. The Department of Agriculture has been appealed to by both railroads and shippers, and the position of the department is tentatively announced as follows: If cars are not loaded beyond the minimum weight fixed by the tariffs, the department will not, for the present, raise the question as to whether sufficient space is provided for the animals to rest; but railroads which load beyond the minimum and do not unload for rest will have to take their chances of prosecution in the courts. It is the intention of the department to institute a number of test cases and secure rulings from the federal courts as to what space must be afforded. It is claimed by the department that this is the only course open, since no power is given the secretary of agriculture by the law to make rulings and regulations regarding space to be afforded in cars. In all cases where live stock is not unloaded en route "into properly equipped pens for rest, water and feeding" the cars must be provided with facilities for feeding and watering in transit, and live stock must, when so fed and watered, receive proper feed and water.

The collection of meteorites in the foyer of the American Museum of Natural History has been enriched by the recently acquired siderite or iron meteorite to be known as Knowles, the name of the post office in Oklahoma nearest to where it was found. The find has not yet been described, but a full account

with illustrations will soon be published. The mass weighs about 355 pounds. There has also been placed on exhibition there the second largest known mass of the siderolite form of the Brenham (Kansas) meteorite. This weighs 218 pounds and replaces the two smaller masses of the same fall that have heretofore been on exhibition.

LECTURES will be delivered in the Lecture Hall of the Museum Building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

July 9—"Botanical Features of the West Indian Islands," Dr. N. L. Britton.

July 16—"Interesting Relations between Plants and Animals," Mr. F. J. Seaver.

July 23—"The Forms of Flowers and their Meaning," Dr. C. C. Curtis.

July 30—"By Canoe down the Yukon River, Alaska," Dr. Arthur Hollick.

August 6—"Edible Mushrooms," Dr. W. A. Murrill.

August 13—"Influences which Govern Local Distribution of Plants," Mr. Norman Taylor.

August 20—"Botanical Cruises among the Bahama Islands," Dr. M. A. Howe.

August 27—"Grasses and their Economic Importance," Mr. George V. Nash.

September 3—"Poisonous Mushrooms," Dr. W. A. Murrill.

September 10—"European Influences in the History of American Botany," Dr. J. H. Barnhart.

UNIVERSITY AND EDUCATIONAL NEWS

CORNELL UNIVERSITY has been made residuary legatee of the estate of Goldwin Smith. It is reported that the value of the bequest will exceed $1,000,000.

BY the will of Frank W. Collendar Tulane University will receive $65,000 for the Sophie Newcomb College. Mrs. Ida A. Richardson, who during her lifetime gave generously to various departments of the university, has left $25,000 to the Medical School.

AT Amherst College associate professors will receive $2,000, instead of $1,600 as formerly; assistant professors will receive from $1,400 to $1,600.

AT Princeton University promotions and appointments have been made as follows: R. B. C. Johnson, preceptor in philosophy, professor of philosophy; Oswald Veblen, advanced to professor of mathematics; Edwin Fitch Northrup, assistant professor of physics; William Foster, assistant professor of chemistry, professor of chemistry; Alfred C. Hawkes, assistant in mineralogy; Vernon A. Suydam, instructor in physics; Claude W. Heaps and Karl T. Compton, assistants in physics; Lewis R. Cary, instructor in biology; John S. Van Nest, instructor in chemistry; Guy F. Lipscomb, Garrett D. Buckner, Joseph S. Laird, Herbert E. Rankin and John I. B. Vail, assistants in chemistry; M. A. Campbell, instructor in geodesy; Edward C. McWilliams, in graphics.

AMONG recent appointments made at the University of Missouri are the following: Professor W. W. Charters, to be dean of the faculty of the school of education; Dr. D. H. Dolley, University of North Carolina, to be professor of pathology and bacteriology; Dr. A. K. Rogers, Butler College, to be professor of philosophy, as successor to Professor A. O. Lovejoy; Dr. J. H. Coursault, assistant professor of history and philosophy of education, to be professor; J. D. Elliff, assistant professor of school administration, to be professor; O. D. Kellogg, assistant professor of mathematics, to be professor; E. J. Durand, instructor in Cornell University, to assistant professor of botany; R. W. Selvidge, instructor in manual training, to be assistant professor; Carter Alexander, fellow in Teachers College, Columbia University, to be assistant professor of educational administration and private secretary to the president; D. H. Doane, formerly with the U. S. Department of Agriculture, to be assistant professor of farm management; Horace T. Major, University of Illinois, to be instructor in landscape gardening with charge of the university campus and grounds; Dr. T. E. Wheelock, of Yale University, to be instructor in physics; Frank W. Capp, to be instructor in civil engineering.

Dr. Ernst A. Bessey, of the Louisiana State University, has accepted the professorship of botany in the Michigan Agricultural College, to succeed Dr. W. J. Beal, who has resigned.

Mr. Robert H. Baker, assistant at Allegheny Observatory, has been elected assistant professor of astronomy at Brown University.

Edmund H. Hollands, Ph.D. (Cornell), has been appointed professor of philosophy in Butler College, Indianapolis. Dr. Hollands has been instructor in philosophy at Cornell University and during this year has been acting professor of philosophy at Hamilton College.

A new department of botany and forestry has been established in the University of Montana. Dr. J. E. Kirkwood has been advanced to the position of professor in charge.

Mr. J. W. Eggleston, assistant in geology, Harvard University, has been appointed assistant professor of geology and mineralogy at the School of Mines and Metallurgy at Rolla, Mo.

DISCUSSION AND CORRESPONDENCE

THE RELIABILITY OF "MARKS"

In connection with the comparison of marks assigned by different examiners in astronomy, published in Science for May 27, a somewhat different experiment of my own in philosophy may be of interest. The course in question was based on Eucken's "Problem of Human Life," and the class consisted of seventeen young women. For each exercise some fifteen pages of the text were assigned, and the students came prepared to make a ten-minute written summary of it. The object, of course, was to see that they did the work, and every student present handed in a paper, even though it contained nothing but her name. The students themselves took turns in marking these papers. It was understood that I was to revise the marks; but, as it turned out, this was not necessary. There were also four tests of an hour each. I was myself to read the papers from these, but actually only read three of them. These tests were announced at the beginning of the year, and the students knew when to expect them. I paid no attention to the marks handed in from time to time by student-markers until the end of the year, at which time I also read and marked the papers from the three hour-tests. These hour-tests, scattered throughout the term, took the place of a final examination.

The marks given by students were computed as follows: The marker for the day marked the papers excellent, good, fair, passable or deficient, with or without a qualifying plus or minus. From these I determined each student's distance above or below the middle of the class, and marked her anywhere from +8 to −8 accordingly. I did not count the mark which the marker gave herself. The fourth column shows the algebraic sum of these marks; the bracketed figure showing the number of separate marks which are added together to make this total. The first column shows the student's standing in the hour-tests, marked by me; and the third shows the figures from which this standing is derived. These figures were actually obtained by assigning numerical values to my own marks of E, G, F, etc., and then multiplying the totals scored in a given test by the fraction necessary to make the highest marks scored in the three different tests equal. My marks were given rather roughly and were not revised.

My Order	Their Order	My Score	Their Score
No. 1	No. 2	78	+63.5 (12)
" 2	" 15	77	−35.5 (11)
" 3	" 8	70[1]	− 2 (10)
" 4	" 1	67	+66 (12)
" 5	" 3	64	+28.5 (11)
" 6	" 6	61	+19.5 (10)
" 7	" 5	58	+28.5 (12)
" 8	" 10	56	−11 (12)
" 9	" 9	55	− 9 (11)
" 10	" 12	51	−26.5 (13)
" 11	" 11	50	−17 (12)
" 12	" 4	47	+30.5 (12)
" 13	" 13	45	−35 (12)
" 14	" 7	44	+18 (12)
" 15	" 14	36	−27 (9)
" 16	" 17	30[1]	−49.5 (11)
" 17	" 16	23	−41.5 (10)

[1] Computed from the results of two tests by adding 50 per cent. to the total.

It will be noticed that the positions assigned by the students of Nos. 2, 3, 12 and 14 differ considerably from those assigned by me. But if these students were omitted from the table altogether the relative positions assigned to the other thirteen by the students themselves on the strength of the ten-minute tests would always come within one place of that assigned by me on the strength of the hour-tests. Nos. 2 and 3, who stand high with me but low with their classmates, impressed me during the term as distinctly intelligent and appreciative. They did much to make the class interesting. But they did not take the daily tests seriously. No. 2 handed in four blank papers, and No. 3 handed in three. They were also absent oftener than any one else in the class, though this did not count in their scores. The papers handed to me by Nos. 12 and 14 were marked low (as I discover on looking at them again) mainly because their treatment of the more comprehensive questions was slight and rather undiscriminating. Their classmates tell me that these two students always learned their daily summaries by heart. Nos. 1 and 4, who stand so far above the others in the students' score, were undoubtedly the most reliable students in the class.

The conclusions which I am disposed to draw from the experiment are that both I and my students can give juster marks than I had dared to hope, but that in my occasional examinations intelligence counts for more than persistent industry, while the reverse is true with short daily tests marked by students.

I may add that the young women were very glad to undertake this work of marking the papers, though they grew tired of the writing. Another year I should probably vary the summaries with questions.

H. AUSTIN AIKINS
WESTERN RESERVE UNIVERSITY,
June 7, 1910

AN UNUSUAL NESTING SITE OF THE MOCKING BIRD

THE nest of the mocking bird, *Mimus polyglottus* Boie, is usually built in hedges, thickets or low bushes. At Thompson's Mills, north Georgia, where this bird is very common, solitary thorn bushes found everywhere in pastures in this locality are favorite nesting sites. The nest is usually placed five or six feet from the ground. It is a rather bulky structure of twigs, stems and weeds, with an abundant lining of fine roots, etc. In early May, 1910, the writer found a mocking bird's nest placed in a rather unusual situation at Thompson's Mills, north Georgia.

This nest was placed about five feet from the ground at the bottom of a roomy hollow in a large, dead tree standing in a pasture. Two round entrances on opposite sides of the trunk led down to the nest, so that the sitting bird could readily escape from the back or front door. The nest, which was constructed of the usual materials, was situated about six inches below these lateral openings and contained four eggs. Although mocking birds very rarely utilize hollow trees for nesting sites, it is evident that a nest placed like the one described has many advantages. It is perfectly sheltered from severe weather, and receives the usual amount of illumination in keeping with a mocking bird's nesting instincts.

Records of mocking birds nesting in hollow trees are very rare. Oliver Davie in "Nests and Eggs of North American Birds," mentions a single instance where a mocking bird's nest was found in a hollow of a live-oak tree in 1898.

In a study of the nesting habits of birds it soon becomes evident that the nesting sites and material chosen show more or less adaptation to local conditions. Strong hereditary trends of habit are characteristic of the different species of birds, but a visible expression of some of these must depend upon the limitations of environment. It occasionally happens that some individuals among birds seem to have lost entirely the normal nesting instincts of their kind, but such instances have no ready explanation.

H. A. ALLARD
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.,
June, 1910

THE INTERNATIONAL SCIENTIFIC ASSOCIATION

To the Editor of Science: Will you permit me, through the columns of Science, to call the attention of American scientists to the meeting of the International Scientific Association (*Internacia Scienca Asocio*), which will occur in conjunction with the Sixth International Esperanto Congress, in Washington, D. C., next August. It is requested that all scientists who are interested in Esperanto, but not yet members of the *Internacia Scienca Asocio*, and also all scientists who wish to investigate for themselves the practicability of Esperanto as an international language for scientists, attend these meetings. The Esperanto Congress opens August 14, and closes August 20. The *Internacia Scienca Asocio* will convene not later than August 17. For information concerning tickets, program, hotel accommodation, reduced railway rates, etc., address the Secretary of the Sixth International Esperanto Congress, Washington, D. C.

Edwin C. Reed,
Secretary

SCIENTIFIC BOOKS

History of the Human Body. By Harris Hawthorne Wilder, Professor of Zoology in Smith College. New York, Henry Holt and Company. 1909. Pp. 573, 150 figs., 8 pls.

The author states in the preface that

> This book has a twofold purpose: *first*, to present the results of modern anatomical and embryological research relative to the human structure in a form accessible to the general student, and, *secondly*, to furnish students of technical human anatomy with a basis upon which to rest their knowledge of details.

The volume can be read with interest and profit by persons who have no special training in biology and consequently it meets most excellently the requirements of the first part of the author's purpose. It is perhaps not so well adapted to the needs of the human anatomist. The plan of the book is somewhat unique. The first three and last chapters are of a very general nature and contain an exposition of the general principles of evolution, phylogenesis and embryology. Its main part, consisting of eight chapters, contains a detailed discussion of the several organ systems from the standpoint of the comparative anatomist.

After discussing the continuity of life and distinguishing between ontogeny and phylogeny, the author presents, in the first chapter, a series of twelve "laws," six of which describe "the characteristics of the phylogenetic record," the remainder being devoted to "an exposition of developmental history or ontogenesis." These so-called laws are merely short statements of certain biological facts or deductions, as will be seen from one example (p. 24).

> In studying an embryological record one must constantly distinguish between palingenetic characters, or those which are true repetitions of the past history, and cœnogenetic characters, or those which have been more recently acquired as the result of some special adaptation. One of the most universal among these latter is the presence of yolk, a food supply for the embryo, which lies between or within the cells and, when excessive, causes misleading distortions in the proportion of parts and effects the obliteration of many important features.

These statements, owing to their brevity, are necessarily inaccurate and incomplete, but, as a whole, they give the reader a general conception of evolution.

In the second chapter, The Phylogenesis of Vertebrates, the author traces the ancestry of man from *Amphioxus* upward through the vertebrates and mammals. The last chapter, which really belongs with the second, contains a discussion of various theories of the origin of vertebrates. These chapters probably form, for the general reader, the most interesting part of the book, but, owing to the indefiniteness of our knowledge of animal descent, are of less value to the student of anatomy.

The third chapter is entitled The Ontogenesis of Vertebrates. It gives as accurate an account of so large a subject as can well be condensed into so short a space, but it may be questioned whether the limitation of the treatment to human development would not have given a better knowledge of the history of the human body.

The comparative anatomical part of the book is to be heartily commended. There are a number of errors here, but considering the large scope of the work and the rapidly enlarging knowledge of anatomy, these are readily pardoned.

As a whole the volume has the faults of its virtues—to mention the latter first; it accomplishes the author's purpose of making the evolutionary theory the framework for many otherwise uncorrelated facts. To do this the treatment has been made *a priori* and is therefore scarcely in accord with the method which has yielded the material of the book.

LEONARD W. WILLIAMS

The Black Bear. By WILLIAM H. WRIGHT. Illustrated from photographs by the author and J. B. KERFOOT. New York, Charles Scribner's Sons. 1910.

This is one of the most refreshing books on wild animals which it has been the writer's pleasure to read for some time. It is, in a way, a monograph on the habits of a single species of North American mammals. The book, which is a small one of only 127 pages with 12 photographic illustrations, is well worth the attention of those interested in the life histories of our living mammals. The observations recorded in the pages of this little book are those of a hunter-naturalist with a tendency toward scientific thought.

The book opens with a story of the capture of a cub of a black bear in the forests of the Bitter Root Mountains, in Idaho. The interest in the story is somewhat broken by the introduction of a chapter on the classification of bears, which might profitably have been omitted, since it draws only a smile from the trained mammalogist and usually contempt from popular readers. The chapter on description and distribution, as well as the ones on habits and food, is quite good. The observations are those of an actual acquaintance of the bears made through twenty-five or thirty years' experience in tramping the forests and mountains of the west. Natural history would be much sounder and naturalists much wiser if we had more productions like "The Black Bear." ROY L. MOODIE

THE UNIVERSITY OF KANSAS

NOTES ON ENTOMOLOGY

THE "candle-fly" of China, like the "lantern-fly" of South America, was long thought to be luminous; now it has been investigated by Messrs. J. C. W. Kershaw and G. W. Kirkaldy and found to be entirely without light-giving powers.[1] The adults suck the sap of several kinds of trees; the eggs (about 80) are laid in straight rows on the bark of the trees, covered with a hardening fluid, and brushed over with a white waxy material. The young feed on various plants, but are not easily discovered, since the head is prolonged in a thick rough process resembling a broken twig. The *Pyrops* secretes a mass of waxy threads, which collects over the wax-pockets and near the spiracles; a species of mite lives in this material. The adult insect is the host of a remarkable parasitic moth (*Epipyrops*), as many as three in one insect.

A RECENT number of the *Memorias do Instituto Oswaldo Cruz* (Rio Janeiro, Vol. I., 1909) contains two articles of interest to entomologists. One by Dr. A. Lutz, "Beitrag zur Kenntnis der brasilianschen Simuliumarten," is a revision of the black flies of South America. Eleven species are recognized, six being described as new. The other article is by Dr. C. Chagas, "Ueber eine neue Trypanosomiasis des Menschen," pp. 159–218, 5 pls. This disease is similar to the African sleeping sickness, and is considered to be transmitted by certain blood-sucking reduviid bugs, especially *Conorhinus megistus* Burm. A small species of monkey, *Callithrix pencillata,* is thought to be the reservoir of the disease. One of the plates illustrates the *Conorhinus.*

AN elaborate investigation into the amount of variation within a genus has been completed by A. Delcourt.[2] He selected the aquatic hemiptera of the genus *Notonecta,*

[1] "A Memoir on the Anatomy and Life-history of the Homopterous Insect, *Pyrops candelaria* (or Candle-fly)," *Zool. Jahrb., Abt. Syst.*, XXIX., pp. 107–128, 1910, 3 plates.

well known as varying greatly in coloration. He has examined large series of six (one new) European and three North American species, and given many notes on geographic distribution, replacement of one species by another, habits, comparative abundance, etc. The plates illustrate the variation in color, several species ranging from pale yellowish to black.

"The Fauna of British India" is rapidly becoming a very important work for all entomologists. To the several valuable volumes already issued Mr. Malcom Burr has added a volume on the earwigs (Forficulidæ) of India.[3] The author has examined nearly all the types, and figures almost all of the 133 species. He gives an outline classification of the earwigs of the world; structural characters, habits, food, maternal care of young, and geographical distribution of the group. He considers that the forceps are weapons of offense and defense, but are also used to test and hold food. Their food is usually dead insects.

Volume XVII. of the *Memoirs of the Entomological Society of Belgium* contains two important papers on coleoptera. One, by Professor A. Lameere, a continuation of his revision of the Prionides, pp. 1–70, contains synopses of genera, *Derancistrus, Pœcilosoma, Calocomus, Pyrodes* and *Sobarus.* The other paper is by F. Eichebaum, a catalogue of the genera of Staphylinidæ, pp. 71–278. Under each genus are the references, the generic description, distribution, number of species and habits of the known larvæ. Over 800 genera are thus treated, containing nearly 12,000 species.

The new parts of Schenkling's "Coleopterorum Catalogus" are part 4, Ipidæ, by M. Hagedorn, 134 pages (this name is used for the beetles known to us as Scolytidæ); he also includes references to the habits of these bark-beetles; part 5, Cupedidæ and Paussidæ, by R. Gestro, 31 pages; part 6, Apioninæ, by H. Wagner, 81 pages; part 7, Brenthidæ, by H. von Schönfeldt, 57 pages; part 8, Lucanidæ, by G. van Roon, 70 pages; part 9, Lampyridæ, by E. Olivier, 68 pages, he also gives references to descriptions of larvæ; part 10, Rhagophthalmidæ and Drilidæ, by E. Olivier, 10 pages; part 11, Temnochilidæ, by A. Leveillé, 40 pages, and part 12, Endomychidæ, by E. Csiki, 68 pages. Each part can be purchased separately.

Dr. O. M. Reuter with aid of B. Poppius has issued a first part of a monograph of the Nabidæ.[4] This part deals with all of the family except the Reduviolina. There are but few new species; eight genera and eighty species are described in this part.

R. Becker is the author of a valuable paper on the mouth parts of dipterous larvæ.[5] The article treats almost wholly of the lower groups of Diptera, *Chironomus, Simulium* and *Tipula,* but has a chapter on the reduction of the head as found in *Musca* and *Anthomyia.*

Dr. Kertész has issued another volume of his world catalogue of flies.[6] This includes three families, the Empidæ, with 1,547 species; the Dolicopodidæ, with 1,386 species, and the Musidoridæ, with nine species. The genus *Lonchoptera* is replaced by the earlier name *Musidora,* although this name was abandoned by its author.

Mr. W. F. Kirby has completed the catalogue of the Orthoptera by the issuance of the third volume,[7] which treats of the Locustidæ, better known to us as Acrididæ, or grasshoppers. This volume also includes additions to the previous volumes.

Nathan Banks

[3] "Recherches sur la variabilité du genre Notonecta," Contribution à l'étude de la notion d'espèce, *Bull. Sci. France Belgique,* XLIII., pp. 373–421, 2 col. plates, 1910.

[3] "The Fauna of British India, Dermaptera (Earwigs)," London, 1910, pp. 217, 10 pls.

[4] "Monographia Nabidarum orbis terrestris," *Act. Soc. Sci. Fenn.,* XXXVII., No. 2, 62 pp. 1 pl., 1909.

[5] "Zur Kenntnis der Mundteile und des Kopfes der Dipteren-Larven," *Zool. Jahrb.,* Abt. Anat., XXIX., pp. 281–314, 3 pls., 1910.

[6] "Catalogus Dipterorum husque descriptorum," Vol. VI., pp. 362, 1909, Budapest.

[7] "A Synonymic Catalogue of Orthoptera," III., British Museum, 1910, pp. 674.

THE STUDY OF TROPICAL FORESTS

DR. H. N. WHITFORD in a recent private letter from Manila announces the publication of a work on "The Composition and Volume of the Dipterocarp Forests of the Philippine Islands." This volume is issued by the Forestry Bureau of the Philippine Islands and represents several years of active field work by its author. The magnitude and financial value of these forests are strikingly shown by a single quotation:

> Our virgin forest area comprises 25,000,000 acres and has 200 billion board feet of timber standing on it. This is a good showing when compared with the 400 billion feet of timber on the 200,000,000 acres of the United States forest reserves.

Dr. Whitford is now at work on a larger and more complete monograph on "The Forests and Principal Forest Trees of the Philippines," which will be a much more extended treatise.

The success of the forestry work done by our forestry service in the Philippines has won the approval and admiration of all the governments interested in tropical forests. The *Cable-News American* of Manila of February 10, 1910, compliments Major George P. Ahern, director of forestry of the Philippine Islands, and relates that Dr. Treub, former director of the Botanical Gardens of Java, has sent a man to Manila to study the American forestry methods. The Inspector General of Exploration of Portuguese East Africa has written asking Major Ahern if he can send two experts to organize a similar survey for the African forests. Major Ahern in replying states some facts that will be of interest to Americans in general.

> The Bureau of Forestry has had the difficult task of investigating, protecting and developing the enormous forest areas of the islands without adequate men and funds for carrying on the work. In spite of these difficulties, however, most of the forests have been classified, estimated and mapped, and we now know what the forests of the Philippines contain, where and how the different forest types are situated, and the approximate cost of placing their lumber on the market.
>
> The forest wealth of the Philippines is found most largely, not in the high-priced cabinet woods (although when considered alone their value is very large), but chiefly in the stands of cheaper structural timbers, such as may be used for most purposes in place of Oregon pine and Baltic fir and other similar timbers in Europe and America. This is distinctly advantageous, although it is contrary to the general idea of the composition of tropical forests. The value of the timber is further increased by the fact that the structural species often occur in almost pure stands and in large quantities, making their logging by modern steam methods comparatively simple and economical.
>
> I believe that the structural possibilities of tropical forests have been decidedly underrated, and that an investigation of other countries besides the Philippines will show large bodies of timber that can be lumbered cheaply and used for general construction purposes, for which there is always a large and steady demand.

Major Ahern says frankly:

> Of all the men who under my direction have had charge of the forest work in the Philippines, chief credit is due to two foresters for what has been accomplished. These are Dr. H. N. Whitford, chief of the Division of Investigation in this bureau, and Mr. H. M. Curran, forester in the same division.

These two men have an ambition to explore and take an inventory of tropical forests in general, the world around, and are hoping to obtain financial aid from the various countries interested, and possibly from private sources, and to organize extensively for the work. If these plans are prospered it will call for the aid of several foresters, and this should be of interest to a number of well-trained men from our American schools of forestry.

Dr. Whitford is firmly convinced that the "value of the tropical forests as a world asset is not appreciated simply because our knowledge concerning their possibilities is so limited." If his great plan can get the proper financial backing he is in a position to do a bit of pioneering and surveying that will open up to the world's commerce, immense wealth in tropical timber never dreamed of hitherto.

J. PAUL GOODE

UNIVERSITY OF CHICAGO,
May 9, 1910

SPECIAL ARTICLES

SKETCH OF THE GEOLOGIC HISTORY OF THE FLORIDIAN PLATEAU[1]

Recently I have endeavored to bring together the data bearing on the geologic history of the Floridian Plateau, and have an essay in press as one of the Contributions from Tortugas Marine Biological Laboratory of the Carnegie Institution of Washington. A summary of the evidence and conclusions was presented before the Geological Society of Washington, at its meeting on April 27, and a concise statement of the conclusions is given in the succeeding remarks.

The agencies which originally shaped, and subsequently dominated, the development of the plateau were of two kinds: (1) those that caused warpings of the earth's crust; (2) those resulting in the deposition of material on the sea-floor, viz., corrosion and erosion of the land surface above sea-level, transportation to the sea, transportation and deposition of land-derived material in the sea, and organisms which added their skeletal remains to the material of inorganic origin.

The plateau existed in Vicksburgian, lower Oligocene time, forming a projection, as a submarine platform, of the southeastern corner of the continental shelf and extending at least to its present southern limit. This older Oligocene platform was due to a fold of the ocean bottom, perhaps in some way connected with the angle of the Piedmont area in central Georgia. During this period the water over this plateau was shallow, perhaps in no place 100 fathoms deep; the bottom temperature was between 70° and 80° F.; tropical currents passed over its surface; deposits of both terrigenous and organic origin accumulated on it in thickness ranging from 100 to 200 feet near the northern shore, to over 1,000 feet near its southern margin. As the water was shallow, the sea bottom must have been gradually depressed while the material accumulating on its surface was being deposited.

At the close of Vicksburgian time the plateau was elevated and areas of its surface were subjected to subaerial denudation, as is attested by the erosion unconformity along the contact of the basal Apalachicola with the underlying Vicksburg sediments.

Apalachicolan time needs separation into two stages: an earlier, represented by the Chattahoochee, Hawthorne and Tampa formations; and a later, represented by the Alum Bluff formation.

The areal extent of the deposits of the earlier stage was not so great as that of the Vicksburg deposits, indicating the later was not so extensive as the previous submergence. The northern shore-line was seaward of that of the Vicksburg Group, it seems probable that a small island may have existed in the sea in what is now the northeastern corner of Marion County, and in other areas the sedimentation over the Vicksburg deposits was thin. Along the western coast of Florida the Vicksburg formations were being gently folded, and a dome-like structure was developing southward. The plateau had practically the same outline as at present; the depth of water north of Tampa was probably in no place over 100 feet. Coral reefs were present in southern Georgia, across the base of the present peninsula, and around Tampa; the temperature was tropical, the minimum for the year being at least as high as 70° F.; the main movement of the ocean water was from the tropics; the sediments consisted to a lesser degree of organic débris, predominantly of terrigenous constituents.

In the later stage of Apalachicolan sedimentation, the island of Oligocene lying west of the present longitudinal axis of the peninsula, had by further uplift increased in size, and was separated from the mainland to the north by the Suwanee Strait. There was differential earth movement, the sea bottom being depressed around the island and between it and the shore of the mainland to the north, permitting additions to the thicknesses of Apalachicola sediments. During this later stage of the Apalachicola, the oceanic waters of the region gradually cooled, and coral reefs disappeared. The sediments were mostly of terrigenous origin and were laid down in shallow water.

This period of deposition was succeeded by one of uplift and subaerial erosion, the Apa-

[1] Published by permission of the president of the Carnegie Institution of Washington and the director of the United States Geological Survey.

lachicolan-Miocene Interval. After this followed the Miocene subsidence. The Miocene subsidence was not so extensive as that of the preceding deposition period, and although it seems probable, it is not positively proved, that the Suwanee Strait was again open water. The Miocene deposits did not extend so far inland as the margin of the Apalachicolan sea, and there were extensive land areas west of the present longitudinal axis of the peninsula. The plateau had approximately its present outline, and thick deposits of arenaceous sands were formed practically to its southern limits, positively as far south as the locality of Key Vaca. The sea was shallow (perhaps 25 fathoms is a safe maximum), there was depression coincident with deposition on the east coast; the waters were cool, a cold inshore counter-current lowering the temperature to that at present prevalent in the region between Cape Hatteras and Long Island. This southward moving counter-current, aided by the winds and the tides, is largely responsible for the greater thickness of sediments on the east than on the west coast, and it is the forerunner of the series of counter-currents so important in the later history of the region. Toward the close of the Miocene period uplift was again initiated, and the Suwanee Strait, should it not have been previously closed, was then assuredly above sea-level, and the north and south Trail Ridge was formed. The uplift seems to have been greater on the east than on the west, for no Miocene is above sea-level from Levy to Pasco counties on the west coast, while submerged Miocene is apparently present off the mouth of Tampa Bay.

The Pliocene submergence was extensive, over half of the present land surface of the peninsula lying below sea-level. The submergence of the present land surface extended down the west side of St. Johns River valley along the east coast, and entirely across the median portion of the peninsula northwest of Lake Istokpoga. No known marine Pliocene occurs on the west coast north of the Charlotte Harbor localities. The general outline of the plateau remained as it was in Miocene time; the water was shallow, usually between 20 and 30 feet in depth; the temperature was tropical in the southern, Caloosahatchee area; and warm, but slightly cooler, in the northeastern area in the vicinity of Nashua. The oceanic currents over the Pliocene bank must have been a warm counter-current—a counter-current because sands were brought from the north and deposited on the Pliocene submarine bank.

While Pliocene marine deposition was taking place, important lacustrine and fluvial deposits were accumulating on the land surface above the sea.

Pliocene deposition was closed by another uplift of the plateau. Data for a precise estimate of the height of the land during this emergence are not available, but the evidence obtainable indicates that it was not over 200 or 250 feet as a maximum, and as the previous movements of the plateau were differential it is most probable that only portions were subjected to oscillations so great. Accompanying this oscillation a shallow syncline was developed along the axis now occupied by the Kissimmee River, with low anticlines on each side. Probably a third anticline was developed west of Peace Creek. The axes of these folds are parallel to the longitudinal axis of the peninsula, and have been important in influencing the drainage courses of middle Florida.

The Pleistocene submergence was as extensive as that of the Pliocene—all Pliocene areas, perhaps, but not probably, excepting one between St. Johns River and the east coast, being resubmerged, and there is a border of Pleistocene on the west coast and the western extension where Pliocene is not now known. The plateau during Pleistocene time preserved its general outline. Shallow water conditions prevailed over its entire submerged portion, in no place were the known deposits laid down in water much deeper than 50 feet, and usually from barely below sea-level to 25 or 30 feet. The temperature north of the latitude of the southern end of Lake Okeechobee was slightly cooler than in Pliocene time, but it was still warm. In this shallow, warm sea sediments of diverse kinds were deposited. Sands and shell marls are probably the most extensive, forming wide-spread deposits over

practically the entire submarine bank. The sands extend beneath the limestone formations as far south as Miami, and perhaps to the southern keys. Along the more northerly portions of the bank coquina accumulated; along a curve, first southward and then bending westward, from Biscayne Bay, a coral reef flourished, separated by a channel of deeper water from the main bank, on which the Miami oolite was forming or had formed in shoal water, strongly agitated by currents. Along the southwestern portion of this bank, also in shoal water, the Lostmans River limestone accumulated. West of the coral reef, on an extensive flat in shoal water, the Key West oolite was formed. Toward the close of the Pleistocene the previously formed sands, marls and limestones southward beyond Miami received a thin coating of siliceous sand. Contemporaneous with this purely marine work, the terracing of rivers to the north was taking place.

Pleistocene time was closed by an uplift, which may have been intermittent, or may have been accompanied by oscillations. There is some evidence of slight depression since the principal uplift. After this uplift the living coral reefs developed, the Everglades were formed, and the Florida of to-day was the result.

Deformation.—The Floridian Plateau owes its origin to a fold of the sea-floor in pre-Oligocene, probably Eocene, time, producing a platform on which sediments during the later geologic periods were laid down. The whole earth mass, since the origin of the platform, has been subjected to a succession of deformations due to compression between forces acting from the east and west, resulting in the axes of the gentle folds coinciding in direction with the longitudinal axis of the plateau. An uplift with deformation took place, as nearly as can be determined, toward the close of the Vicksburgian deposition period. The Vicksburgian nucleus lay nearer to the eastern than the western margin of the plateau, and was roughly dome-like in form, but with a longer north and south than an east and west axis. The subsequent growth of the peninsula was by filling the channel between the island of older Oligocene (Vicksburgian) rocks and the mainland, and by growth eastward and southward from it. There was little or no westward growth. There was additional deformation in later Oligocene (Apalachicolan) time, between the Apalachicolan and Miocene deposition periods, between the Miocene and Pliocene, between Pliocene and Pleistocene, and succeeding the Pleistocene deposition. The result of each of the series of deformations was to add, beginning with the Miocene-Pliocene number of the series, one or more anticlinal swells with intermediate synclinal depressions to those that preceded, the additions above sea-level always taking place toward the east, and at each elevation the uplifting was propagated southward. The continued effect of all the uplifts was to elevate the eastern portion of the plateau above the western, or there has been elevation on the eastern side of the plateau coincident with stability or even slight depression on the western side.

Currents.—The ocean currents, combined with winds and tides, have been important in shaping the land area of Florida. Before the history of the currents of the region can be thoroughly understood it is necessary to know the history of the Hatteras Axis of North Carolina. The present Florida counter-current seems to be due to the impingement of the Gulf Stream against the Hatteras projection, resulting in a portion of the waters being deflected southward along the coast, instead of continuing their northward journey. The Hatteras Axis has existed as a dividing line between depositional areas apparently since middle Cretaceous time, and it has been either a region of shoal water, or occasionally a land area, since later Eocene time. The Vicksburgian and Apalachicolan seas were both warm, tropical or subtropical in temperature. It is not definitely determinable at present whether the warmth of these waters was due to currents directly from the tropics or to a warm return current produced by the northward flowing Gulf Stream having a portion of its waters diverted southward by impinging

against a salient from the more northerly land area. There is some evidence in favor of the latter view.

In Miocene time it is definitely known that a cold inshore current found its way southward to Florida and westward to Pensacola. This current may be due to the Miocene submergence of the Hatteras area, which sufficiently lowered the sea bottom off Hatteras to permit the Gulf Stream to continue its course unobstructedly northward, at the same time permitting a cold inshore current to move southward. The Miocene southward current, aided by winds and tides, transported quantities of terrigenous material and deposited it on the eastern border of the Floridian Pleateau.

Since Miocene time there have constantly been return currents of warm water (however, not so warm as the Gulf Stream), and they have, aided by the winds and tides, transported terrigenous material which was deposited on the eastward side of the existing land areas, sweeping a portion of it to the southern end of the plateau. These currents were active during Pliocene and Pleistocene times, and are still active to-day.

The shape of the upper surface of the Floridian Plateau, the land area of its eastern side, the arrangement of the geologic formations of successive ages, the directions of the stream courses, and the contour of the present coast line, owe their peculiarities and characteristics to the concomitant operation of the forces producing deformations and to oceanic currents.

T. WAYLAND VAUGHAN

GLACIAL LAKES OF THE CATSKILL VALLEY

THE Hudson lobe of the waning Wisconsin ice sheet blockaded the southeastern embouchure of the Catskill Valley, and sent a blunt "thumb" into this depression, pressing against the northeast front of the Catskills. The highest impounded waters were continuous with Schoharie Valley lakes recognized by Fairchild, by way of the summit col at Franklinton, Schoharie County. Then eastward escapes were apparently found between the ice-margin and the Catskill front, carving three or four sets of roughly parallel channels for eight miles between Hervey Street and Cairo Round Top.[1] The series of falling lakes thus determined have as their lower limit the notch behind the Round Top, at about 600 feet, and to this level may be given the name "Lake Durham." The channelings have caused interesting stream diversions, especially of former Shingle Kill headwaters through this notch into the Kiskatom.

The next escape was east of the Round Top, at Cairo Junction, and southward by a minor body ("Lake Kiskatom") into the gorge of the Kaaterskill at Great Falls, and to Lake Albany near Asbury. This lake, at 350 feet, is marked also by a cobble delta of the Catskill north of Cairo, discovered by W. M. Davis. It may be called "Lake Cairo." The hypo-Cairo channels are east of Vedder Hill, near Leeds, between the steep shale slope and a flanking moraine. A mile south of the hill the waters entered Lake Albany and built a shale-pebble delta now largely submerged under Albany clays. Shortly afterward Lake Albany entered the valley and established a grade-plane of which there are extensive remnants at Leeds depot, the mouth of Potuck Creek and at Sandy Plains north of South Cairo. It is significant that these remnants are of much coarser material than the present lower flood-plains of the Catskill, indicating strong drainage from the north, which apparently came around the east face of the Helderbergs via Clarksville, Lawson Lake, etc., and through the Cabin River and Potuck valleys. Heavy scourings at Result and Urlton, noted by Fairchild, are probably due to these waters, which may have included even Mohawk drainage.

The delta of the Catskill in Lake Albany, associated with this grade-plane, is found in Jefferson and West Catskill, now bisected by the creek. It extends four miles south and has crowded the Hudson to the east, but has merely blockaded, without filling, the valley of the Hans Vosen Kill on its north. In the

[1] See Durham, Coxsackie, Kaaterskill and Catskill topographic sheets.

later down terracing, the Catskill encountered a rock-ridge near its mouth and developed behind it an interesting meander-curve at about the hundred-foot contour in West Catskill, left as an elevated oxbow.

The entire problem deserves more extended field work.

George H. Chadwick

Canton, N. Y.,
June 3, 1910

On the Stickleback of Lake Superior

In 1850 Louis Agassiz[1] described a stickleback from Lake Superior which he called *Gasterosteus pygmæus*. The species was founded on three specimens, one less than eleven sixteenths, the other two less than one quarter of an inch long. The description given of these covers somewhat over a page. Most of it, however, would apply equally well to any form of the genus *Eucalia*, and there are only the following characters which seem of value as a basis for differentiation: the small size (Agassiz seems to have considered his largest specimen as representing the approximate maximum for the species); the relation of length to depth (eleven sixteenths of an inch, or less, to one eighth or one seventh of an inch); the dorsal fin formula (VI.–7 [?]); and the anal fin formula (I.–6). The supposed species is not discussed by Jordan in the paper in which he first fully describes the genus *Eucalia*, although the name is mentioned.[2] Eigenmann, in his review of the North American Gasterosteidæ,[3] includes it as a variety of *Eucalia inconstans;* and in this form it is taken over into Jordan and Evermann's "Fishes of North and Middle America."[4] This last work has taken over bodily Eigenmann's notes on the form, which notes are, however, inaccurate in ascribing to *pygmæa* a deeper body than to *inconstans*. I can discover no such character in Agassiz's original description. Supposing his largest specimen to have been only ten sixteenths of an inch long, and its depth to have been one seventh of an inch (the most favorable figures to make for great relative depth of body), the ratio will still be about four and one third. This would appear to give a rather more slender body than in typical *inconstans*, but in reality it lies well within the range of variation of *inconstans* as collected from almost any locality.

In the course of making a collection of Wisconsin fishes the State Geological and Natural History Survey had occasion last summer to send a collecting party under the leadership of Mr. H. H. T. Jackson to the Superior shore. Mr. Jackson was instructed to keep a special lookout for sticklebacks in those waters. As a result I have before me various lots of sticklebacks collected from the following places within the Lake Superior Basin: Mamie Lake (Vilas County); Montreal River and Lake La Vine at Hurley (Iron County); Siskiwit River, Siskiwit Bay, and Lost Creek Slough at Cornucopia, Flag River at Washburn, and Pike's Creek at Bayfield (all in Bayfield County).

Agassiz's specimens were taken at Michipicotin, on the northeastern shore of Lake Superior, undoubtedly either in the lake itself or very near it. There is no reason to suppose that any form existing there would not be found in other tributaries of the lake. Such close restriction would be unique among fishes of waters not landlocked. And more especially must this force itself upon us when we consider that *Eucalia inconstans* ranges from Saskatchewan to Ohio, and *Pygosteus pungitius* from France to Alaska, with only a slightly modified form in Greenland.

We feel justified therefore in believing that if *Eucalia inconstans pygmæa* exists, specimens of it would occur among our collections. A careful examination of all our specimens from Lake Superior discloses nothing that is not typical *inconstans*. But an examination of the few characters given for *pygmæa* shows that these in themselves have no value. Let us examine them separately.

First, Size:—This is easily disposed of. Any one who has had considerable experience in field work among our common fishes knows

[1] "Lake Superior," p. 314; Plate IV., Fig. 1.
[2] *Proc. Ac. Nat. Sci., Phila.*, 1877, p. 65.
[3] *Proc. Ac. Nat. Sci., Phila.*, 1886, p. 233.
[4] Bulletin 47, U. S. Nat. Museum, Vol. I., p. 744.

that the average size of any lot of one species of fish is very largely affected by the character of the water from which the lot was obtained. What the particular factors in any body of water are that affect this size is practically unknown. A very interesting case of this kind is found, however, in the common yellow perch of our lakes here at Madison. Lake Mendota, the largest lake, contains more perch per unit of area than any other body of water I have ever examined. But they are all small. Lake Monona, a smaller and somewhat shallower body of water, but freely connected to Mendota, which flows into it, contains a very much smaller number of this species, but they will average twice as large in size. The explanation, so it seems to me, is fairly clear: Lake Mendota (for reasons now unknown, although a greater relative plankton content probably plays a part), is more favorable for the hatching of perch spawn and the adequate nourishment of the young perch, as well as for their protection, or freedom from enemies. The absence of *Stizostedion* may be a factor here. As a consequence a relatively large proportion of the eggs laid develop to a stage where the perch need larger organisms for food. This very abundance of young perch brings about a struggle for the food supply, a struggle which results not so much in the extinction of the weaker individuals, but in a reduction of the amount of food obtained by each individual and hence a reduction in the rate of growth. Such a state of semi-starvation probably has little or no effect on the fecundity of the individuals concerned, for as we now know, the essential reproductive organs are about the last parts of the body to be affected by starvation.[5]

In Lake Monona, on the other hand, we may suppose the conditions for the development of perch eggs, and for the proper nourishment of young perch and their immunity from enemies to be much less favorable. Hence a much smaller number, as compared with the number of eggs laid, would reach the stage when larger food is taken. The much smaller number struggling for the supply of this larger food, would allow each individual a much larger share, and hence a much more rapid rate of growth, which would of course finally result in a much larger average size. That great differences in size among individuals of the same age may be produced thus has been well shown in star fishes, where the disproportion is sometimes startlingly great.[6] That such great differences may be possible demands great resistance on part of the animals against partial starvation, and this we know to exist in fishes as in most other poikilothermous vertebrates.

Similar observations among fishes, more particularly carnivorous fishes, can be made by any one. We believe that in the majority of cases a lake yielding regularly large individuals of a species (large-mouthed black bass for instance) will not yield the species in great numbers, while one yielding many individuals will rarely yield any above average size. This is corroborated in a general way in our collections of Gasterosteidæ from Wisconsin, and is very apparent indeed to any one actually collecting them. The character of size, therefore, can be set aside as of no value whatsoever.

The relation of body depth to total length has already been disposed of. To reach some conclusion concerning the dorsal and anal fin formulæ, I selected an individual of approximately the size of Agassiz's largest, eleven sixteenths of an inch. I measured to the *base* of the tail in order to give his description the benefit of the doubt. Even so, it must be admitted that it is a very small specimen to work with. By means of a binocular magnifying sixty-five diameters, it is comparatively simple to erect the dorsal and anal fins, and count the presence of ten soft rays in each. But Agassiz had no binocular, nor had he the better preserved specimens which result from killing in formalin. Trying to examine this specimen by the ordinary microscope immediately shows how difficult it would have been thus to determine the right number of soft

[5] Stoppenbrink, *Zeitschr. wiss. Zool.*, Bd., 79, p. 496; Schultz, *Archiv f. Entw. Mechanik*, Bd. 18, p. 555.

[6] Mead, *Am. Naturalist*, Vol. 34, p. 17.

rays, and how easy to overlook the smaller ones. Couple with this the uncertainties expressed by Agassiz himself, and the fact that he had only one workable specimen, and I think we are fully justified in concluding that the supposed differences do not exist. It would be in a measure rather remarkable if they did.

An examination of all our Superior specimens of *Eucalia* fails to disclose, as mentioned before, anything whatsoever to distinguish them, or any of them, from *Eucalia inconstans*. Until better evidence is produced of its existence, therefore, we believe that *Eucalia inconstans pygmæa* Agassiz should be dropped from our list of North American fishes.

George Wagner

Wisconsin Geological and Natural History Survey,
May 1, 1910

THE GEOLOGICAL SOCIETY OF AMERICA ELEVENTH ANNUAL MEETING OF THE CORDILLERAN SECTION

The Cordilleran section of the Geological Society of America held its eleventh annual meeting at South Hall, University of California, Berkeley, March 25–26, 1910. As officers for the ensuing year were elected A. C. Lawson, chairman; G. D. Louderback, secretary, and H. F. Bain, councilor.

The following papers were presented and discussed:

The Limestone Plains of the Interior of Bahia: J. C. Branner, Stanford University, Cal.

Limestones, probably of Jurassic age, cover many thousands of square miles in the interior of Brazil, especially in the states of Bahia and Minas Geraes. In many parts of the same region valley floors are covered by recent limestone deposits spread out in horizontal sheets. These later limestones appear to be derived from the older ones by processes now in operation in the same region in modified form.

Geologic Work of Ants in Tropical Countries: J. C. Branner, Stanford University, Cal.

Work of considerable geologic importance is done in most tropical countries by certain ants and by what are popularly called white ants. The white ants are not ants at all, but belong to the Isoptera. The present paper gives the results of observations upon the abundance and habits of these insects, and the amount of earth moved by them in excavating their underground galleries.

Tables for the Determination of Crystal Classes: W. S. Tangier Smith, Reno, Nev.

This paper presents two different keys for the determination of crystals belonging to the thirty-two crystal classes, according to their morphology. One of these tables makes use of a center of symmetry as the basis for its main divisions, while in the other the center of symmetry is not considered. It is intended that in practical use one table may serve as a check upon the other. In the second table the classes are grouped in accordance with the classification recently proposed by Schwartz, while the class names are given according to both Krause and Dana.

The Occurrence of the Halogen Salts of Silver at Tonopah, Nev.: J. A. Burgess, Tonopah, Nev., and A. S. Eakle, Berkeley, Cal.

The occurrence was described of the chlorides, iodides, bromides of silver at Tonopah, and descriptions given of these minerals and associated minerals.

A New Development at the Mouth of the Mississippi: E. W. Hilgard, Berkeley, Cal.

This refers to the uprising of a serious obstacle to navigation outside of the Eads Jetties in the south pass, which has been made the mean outlet of the Mississippi and of navigation, on account of its being the only one of the Mississippi mouths showing no mud-lump activity. Professor Hilgard predicted, however, in 1869 that when the main current of the river was directed into the pass, such activity would begin within twenty to thirty years, as has now happened.

Contribution to the Geology of Eastern Oregon: E. L. Ickes, Berkeley, Cal.

A statement of the general stratigraphy and structural features of eastern Oregon with a more detailed discussion of certain formations and structures specially studied during a recent field trip in the east central part of the state.

California Earthquakes—A Synthetic Study of the Recorded Shocks: H. O. Wood, Berkeley, Cal.

A correlation of recorded shocks with the known faults of the region and especially with those suspected to show recent activity.

Secondary Pseudostratification in Santa Barbara County, Cal.: George D. Louderback, Berkeley, Cal.

There has developed in Tertiary friable massive

sands an appearance of beds and of stratification planes, caused by secondary agencies acting at or near the surface. The appearance was described and illustrated and probable causes discussed.

The Age of the Rancho La Brea Beds near Los Angeles: JOHN C. MERRIAM, Berkeley, Cal.

Notes on the Foundation of the Geological Society: C. H. HITCHCOCK, Honolulu, T. H.

A history of the efforts made to form a Geological Society during the years just preceding the establishment of the Geological Society of America.

Recent Faulting in Owens Valley, Cal.: WILLARD D. JOHNSON, Berkeley, Cal.

The topography of Owens Valley is strikingly immature. It is complex with arrested works of gradation. Deformation has varied as to the type, and the magnitude of its results, the seat of its action, and the periods of its recurrence and gradation, continually modeling toward symmetry again, has made record of the diastrophic events.

The Paragenesis of Minerals: AUSTIN F. ROGERS, Palo Alto, Cal.

Emphasizes the interest and importance of the occurrence, association and origin of minerals. Discusses the use of the term paragenesis. A university course along this line, in which paragenetic varieties of minerals are listed, correlates the facts of mineralogy and petrography and serves as an introduction to the study of ore-deposits.

Ruby Corundum from San Bernardino County, Cal.: GEORGE D. LOUDERBACK, Berkeley, Cal., and W. C. BLASDALE, Berkeley, Cal.

A hitherto undescribed locality recently called to the writer's attention shows the occurrence of corundum as an igneous secretion followed by a history of partial metamorphism, impregnation, brecciation and weathering of the enclosing rocks. The mineral is in part automorphic with very simple forms. The rock and its associations were described, and analyses presented.

Serpentines of the Central Coast Ranges of California: H. E. KRAMM, Stanford University, Cal.

The paper presents a brief history of the work done on the California serpentines. In particular it is a mineralogical and petrological description of serpentines and associated minerals in the central coast ranges of the state. The derivation of the serpentines from eruptive rocks was shown.

Some Topographical Features of the Western Side of the Colorado Desert: H. W. FAIRBANKS, Berkeley, Cal.

The San Jacinto Mountains send out a long spur southeastwardly into the western part of the Colorado Desert. This spur is known as the Santa Rosa Mountain. The accumulations of the desert appear to have been built up against the foot of this range as though it had undergone subsidence.

An arm of the Colorado Desert reaches in behind the Santa Rosa Mountain and this is known as the Borego Desert. At the western end of this desert close under the steep scarp of the Peninsula range, there is an alkali sink evidently due to subsidence of the desert.

At the end of the Santa Rosa Mountain where the Borego Desert opens out into the main Colorado Desert there are extensive beds of late Tertiary age. These have been folded slightly and subsequently planed off. Then an uplift took place and another partial planation occurred. Finally the beds were dissected and at their lower exposed margin eaten into by the waves of the ancient Salton Sea.

There followed a general discussion of the condition of seismological investigations in America and of the proposed establishment by Congress of a national bureau of seismology, and at the conclusion of the discussion the following resolutions were adopted.

The Cordilleran Section of the Geological Society of America favors strongly the establishment of a national bureau of seismology organized under the Smithsonian Institution with power (*a*) to collect seismological data, (*b*) to establish observing stations, (*c*) to study and investigate special earthquake regions within the national domain, (*d*) to cooperate with other scientific bodies and organizations and individual scientists in forwarding the development and dissemination of seismological knowledge.

It regards it of great importance that other scientific bureaus of the national government, in particular the U. S. Weather Bureau and the U. S. Geological Survey, be authorized by law to cooperate with this bureau in forwarding the purposes for which it may be established.

Resolved, that copies of this resolution be transmitted to the President, president of the Senate, speaker of the House of Representatives and members of the congressional committees now considering this matter.

GEO. D. LOUDERBACK,
Secretary, Cordilleran Section

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 232d meeting of the society, held at the George Washington University on Wednesday evening, April 27, 1910, Mr. David White exhibited specimens of coal from Upper Cretaceous near Newcastle, Colo., as illustrating a coal undergoing rapid devolatilization. The coal contains large quantities of occluded gas which is easily detected by the odor of hydrogen sulphide. The hand specimens exhibited continued for a long time to give off the gas after being broken open and crushed, although they had since collection been exposed to the air for nearly twenty months.

Regular Program

The Sulphides of Iron and their Relations to One Another: E. T. Allen and John Johnston. (Delivered by Mr. Allen.) Crystallographic study by Esper S. Larsen.

1. Pyrrhotite was formed: (1) by the slow precipitation of ferrous chloride by the vapors of ammonium sulphide, (2) by the direct union of iron and sulphur, (3) by the decomposition of pyrite. The dissociation of pyrite into pyrrhotite and sulphur becomes noticeable at about 500°, and at 700° the vapor pressure probably reaches one atmosphere. The reaction is reversible. The pyrrhotite melts at about 1200°. Cooled in nitrogen, the product seems to have the composition FeS; cooled in H_2S, it absorbs sulphur. Pyrrhotite appears to be a solid solution of sulphur in FeS. In support of this view, measurable crystals made in the wet were found to have almost the composition FeS. Other lines of evidence are being followed.

2. Pyrite and marcasite were formed by the reduction of ferrous sulphate by hydrogen sulphide between 200° and 300°. The pyrite forms in cubes modified by the octahedron; the marcasite crystals agree closely with the natural mineral ($a:b:c = 0.7660:1:1.220$). The two disulphides are generally obtained together; the conditions giving rise to each are as yet undetermined. Marcasite is an unstable form passing into pyrite. In the dry way the change proceeds slowly at 450° without any loss of sulphur. Although the presence of a solvent might be expected to exert a favorable influence on this transformation, no change was observed at 350° in the presence of aqueous sulphuric acid after several days. If the mineral is heated rapidly, considerable evolution of heat is observed between 500° and 600°. At this higher temperature a little sulphur is lost and some pyrrhotite formed. Natural marcasite does not change into the denser pyrite when compressed at ordinary temperatures at 10,000 atmospheres. The change of marcasite to pyrite was followed by Stokes's method (Bull. U. S. Geological Survey, 186). The investigation is still in progress.

A Sketch of the Geologic History of the Floridian Plateau: T. Wayland Vaughan.

A brief description was given of the present submarine and subaerial topography of the Floridian Plateau and of the marine deposits now forming in shallow water. The ocean currents, winds, tides, were described, followed by a discussion of the principal shore features and drainage lines and a description of the geologic formations and history. The Floridian Plateau was shown to have existed since early Oligocene times and to owe its development to gentle folding due to compression from east and west, combined with the usual presence of marine and subaerial erosion and deposition. The rôle of corals as constructional agents was shown to be relatively unimportant at the present time and of still smaller importance in the past. The plateau has undergone repeated elevation and depression since Oligocene times, the net result being a gradual extension to the east and to the south. At present the entire western half of the plateau is submerged.

Edson S. Bastin,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

The ninth regular meeting of the session of 1909–10 was held at the Chemists' Club on Friday, June 10.

The annual report of the secretary showed an increase in membership of the section of 93, giving a total of 773 members.

The following papers were presented:

Chas. Baskerville and W. A. Hamor: "The Examination of Ethyl Ether."

H. C. Sherman, E. C. Kendall and E. D. Clark: "An Examination of Present Methods of Determining Diastatic Power."

E. C. Kendall and H. C. Sherman: "A Study of the Action of Pancreatic Amylase."

F. J. Pond: "A Case of Iron Corrosion."

Arthur E. Hill: "A Note on the Constancy of the Solubility Product."

C. M. Joyce,
Secretary